PRELIMINARY REPORT ON THE WATER QUALITY OF ROUND LAKE

1975

The Honourable
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Ministry
of the
Environment

Ontario

PRELIMINARY REPORT

ON

THE WATER QUALITY

OF

R O U N D   L A K E

1975

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NORTHEASTERN REGION

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SUMMARY AND CONCLUSIONS

Round Lake may be classified as eutrophic (nutrient enriched) on the basis of chlorophyll *a* - Secchi disc relationships, clinograde dissolved oxygen distributions, high phosphorus, nitrogen and chlorophyll *a* concentrations and excessive phosphorus and nitrogen loadings.

Historically, the Blanche River upstream of Round Lake has received significant quantities of untreated sewage from the communities of Swastika and Kirkland Lake. Inputs of phosphorus and nitrogen to Round Lake via the Blanche River are of a magnitude easily capable of inducing water quality problems and the adverse conditions observed appear to be a response to nutrient additions from this source.

RECOMMENDATIONS

It is recommended that the study be continued, as planned, in order to permit the determination of future changes in nutrient loadings and resultant water quality responses related to the new sewage treatment facility at Kirkland Lake.

1.0 INTRODUCTION

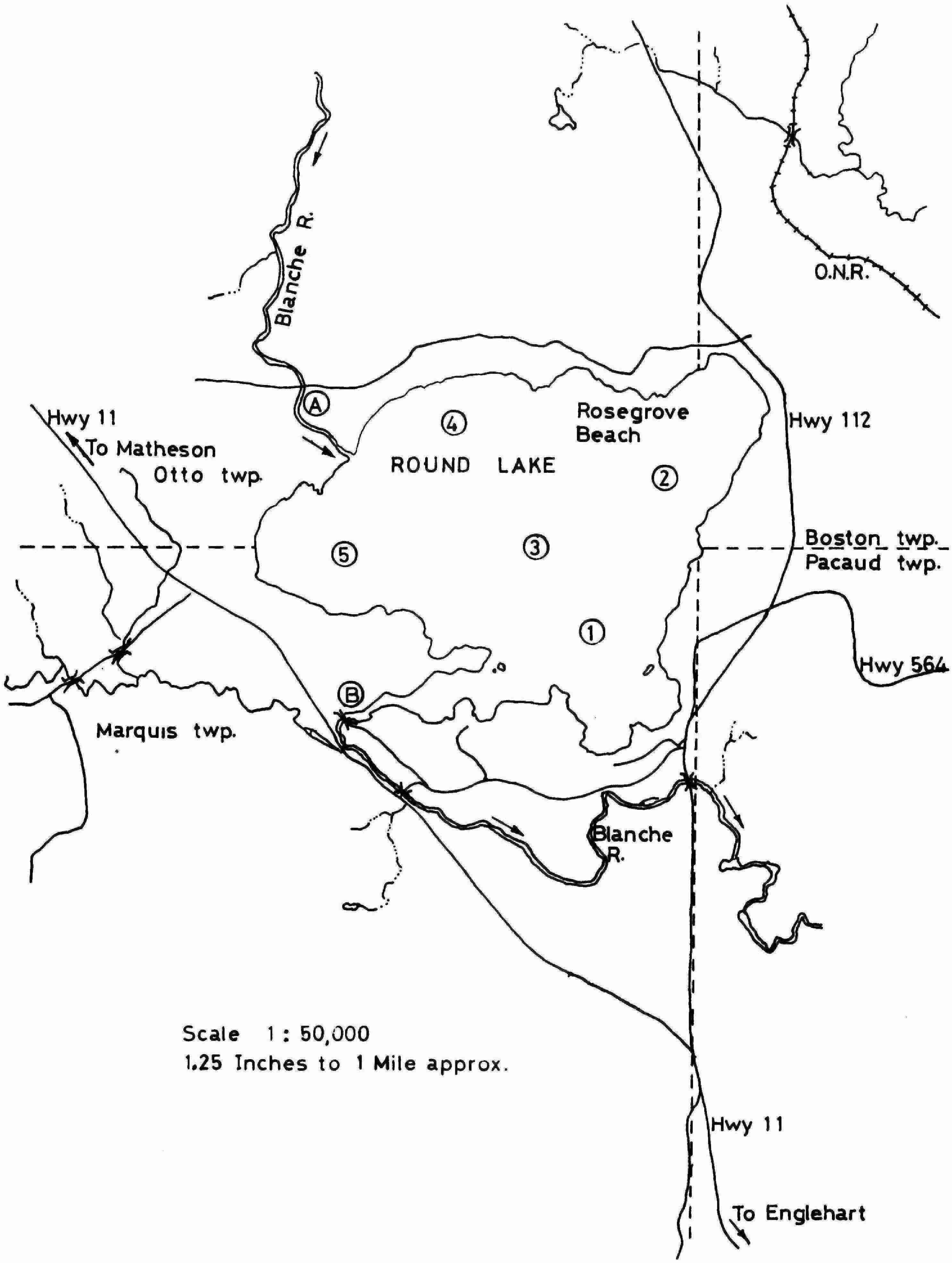
Round Lake is located approximately ten miles south of the Town of Kirkland Lake, (see figure 1). Inflow to and outflow from Round Lake is via the Blanche River. Historically, the Blanche River has received raw sewage from the communities of Swastika and Kirkland Lake, resulting ultimately in a significant nutrient input to Round Lake, located downstream. In November, 1973, a secondary sewage treatment plant commenced operation at Kirkland Lake.

During the summer of 1973, complaints of an algal bloom on Round Lake were received by the Ministry of the Environment and subsequent investigation confirmed the presence of excessive quantities of blue-green algae. Subsequently, during the summer of 1974, a water quality evaluation was implemented in order to document existing water quality and provide baseline data to permit the determination of any future improvements in water quality related to the establishment of the new sewage treatment facility at Kirkland Lake.

The water quality evaluation of Round Lake was based on a "Self Help" programme involving a cooperative approach between the Ministry of the Environment and the public. Under this format, concerned local citizens collected weekly data on Secchi disc transparency (a measure of water clarity) and chlorophyll a concentrations (a measure of algal abundance) throughout the summer. These two parameters provide an indication of the trophic status (degree of nutrient enrichment) of a lake. Additionally, an investigation of other water quality variables was carried out by Ministry staff to supplement the chlorophyll a - Secchi disc data. The maximum value of a chlorophyll a - Secchi disc programme is only realized when the programme is continued over a number of years since the initial years' data provides a base from which future changes and trends may be determined. In this regard, a continuing effort on Round Lake is planned.

The following report provides the results of the 1974 investigation.

FIGURE 1 — MAP OF THE STUDY AREA SHOWING THE LOCATIONS OF SAMPLING STATIONS



Scale 1 : 50,000
1.25 Inches to 1 Mile approx.

2.0 METHODS

2.1 PHYSICO-CHEMICAL

During August, water samples were collected from specified depths with a Van Dorn sampler. Duplicate one l samples in glass bottles were collected per depth and two depths (one m below surface and one m above bottom) were sampled at each location. Samples were retained in a portable cooler during transportation to the field laboratory where pH and conductivity measurements were made. Subsequently, samples were shipped to the Ministry of the Environment laboratory for analyses including:

alkalinity	calcium	nitrogen
hardness	potassium	phosphorus
sulphate	sodium	iron
	magnesium	carbon

In addition, temperature and dissolved oxygen depth distributions were determined in the field.

2.2 SECCHI DISC AND CHLOROPHYLL a

At weekly intervals throughout the summer, stations were sampled for Secchi disc transparency depths and chlorophyll a concentrations.

Secchi disc readings are taken by lowering the disc (20 cm in diameter with alternating black and white quadrants) to the depth at which it just disappears. This depth is recorded and the disc is raised to the point at which it reappears and that depth is recorded. The point halfway between these two readings is the Secchi disc transparency depth.

Chlorophyll a samples were collected as composites through the euphotic zone (zone of significant light penetration - taken as twice the Secchi disc depth). A composite sample is collected by lowering a one l glass bottle in a weighted sampler to a depth equal to twice the Secchi disc reading and then

retrieving it at such a rate to allow complete filling as it reaches surface - the object being to collect water equally fromall portions of the measured sampling column. Figures 2.2.1 and 2.2.2 are schematic representations of the methology of composite sampling and the composite sampler respectively.

Samples for chlorophyll a analyses were immediately stabilized with sufficient magnesium carbonate solution (2% weight to volume ratio) to elevate the pH and retard the breakdown of chlorophyll a during transporation. Samples were shipped to Toronto and analysed in the Ministry of the Environment laboratory within 48 hours of the time of receipt.

FIGURE 2.2.1

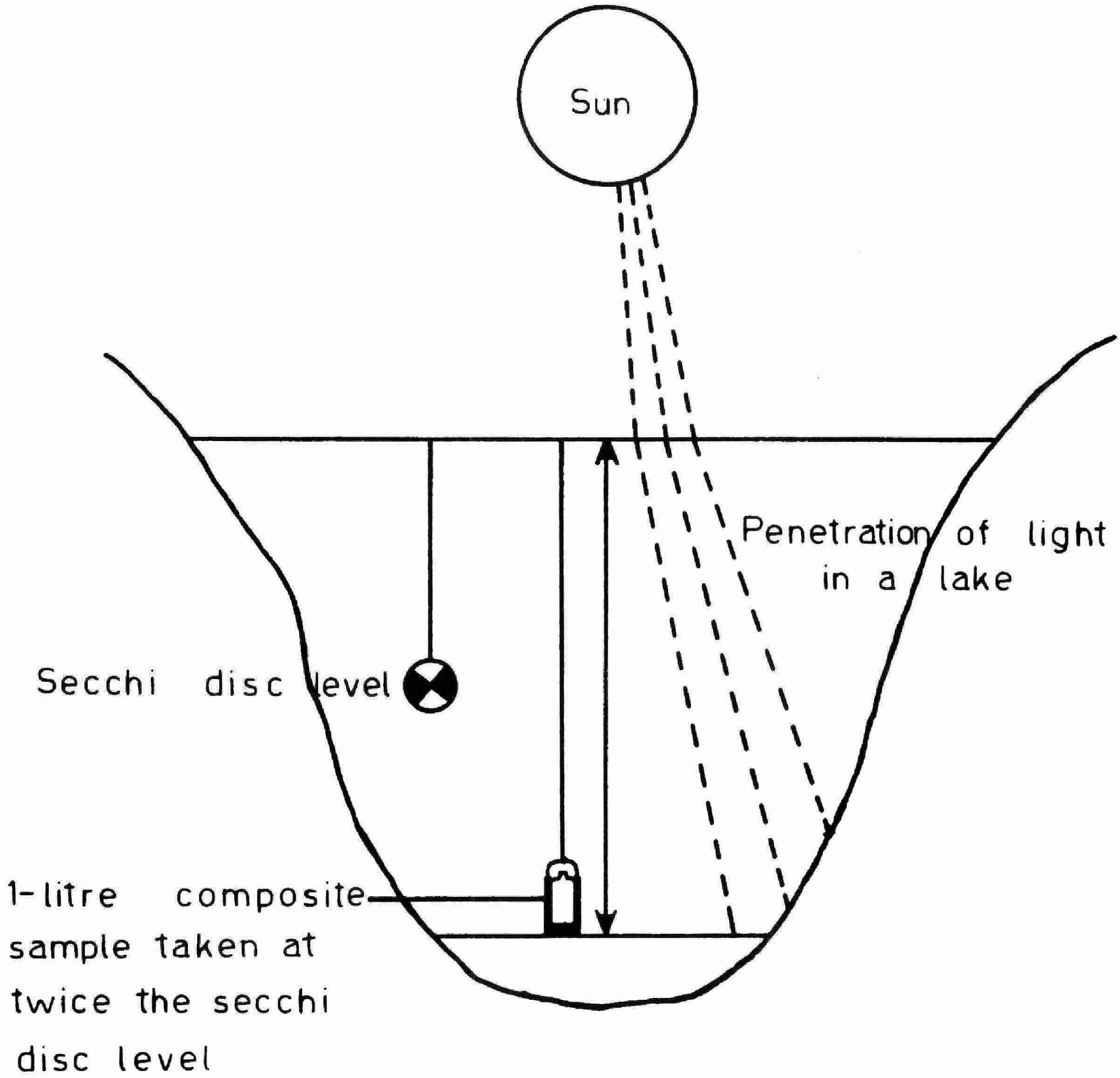
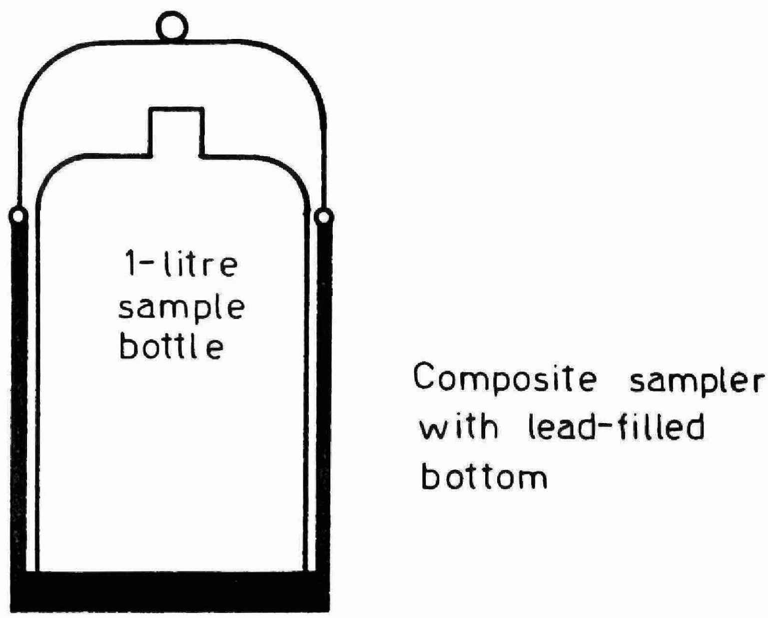


FIGURE 2.2.2



3.0 RESULTS AND DISCUSSION

3.1 TEMPERATURE AND DISSOLVED OXYGEN

The results of temperature and dissolved oxygen measurements on Round Lake are provided in Table 1 of Appendix B. Dissolved oxygen and temperature depth profiles based on the data recorded in Table 1 are depicted in Figure 3.1.1 (note - station 4 was not included since it did not show meaningful thermal stratification).

With the exception of station 4 which lacked sufficient depth for significant thermal stratification, all stations exhibited a reasonably well defined thermocline at the time of sampling. At stations 1 and 2 the thermocline was established between 5 and 10 m while at stations 3 and 5 it was located between 6 and 11 and 6 and 9 m respectively. The strength and definition of the thermocline is extremely important in a lake since it may effectively act as a barrier to chemical diffusion isolating the surface waters (epilimnion) from the bottom waters (hypolimnion).

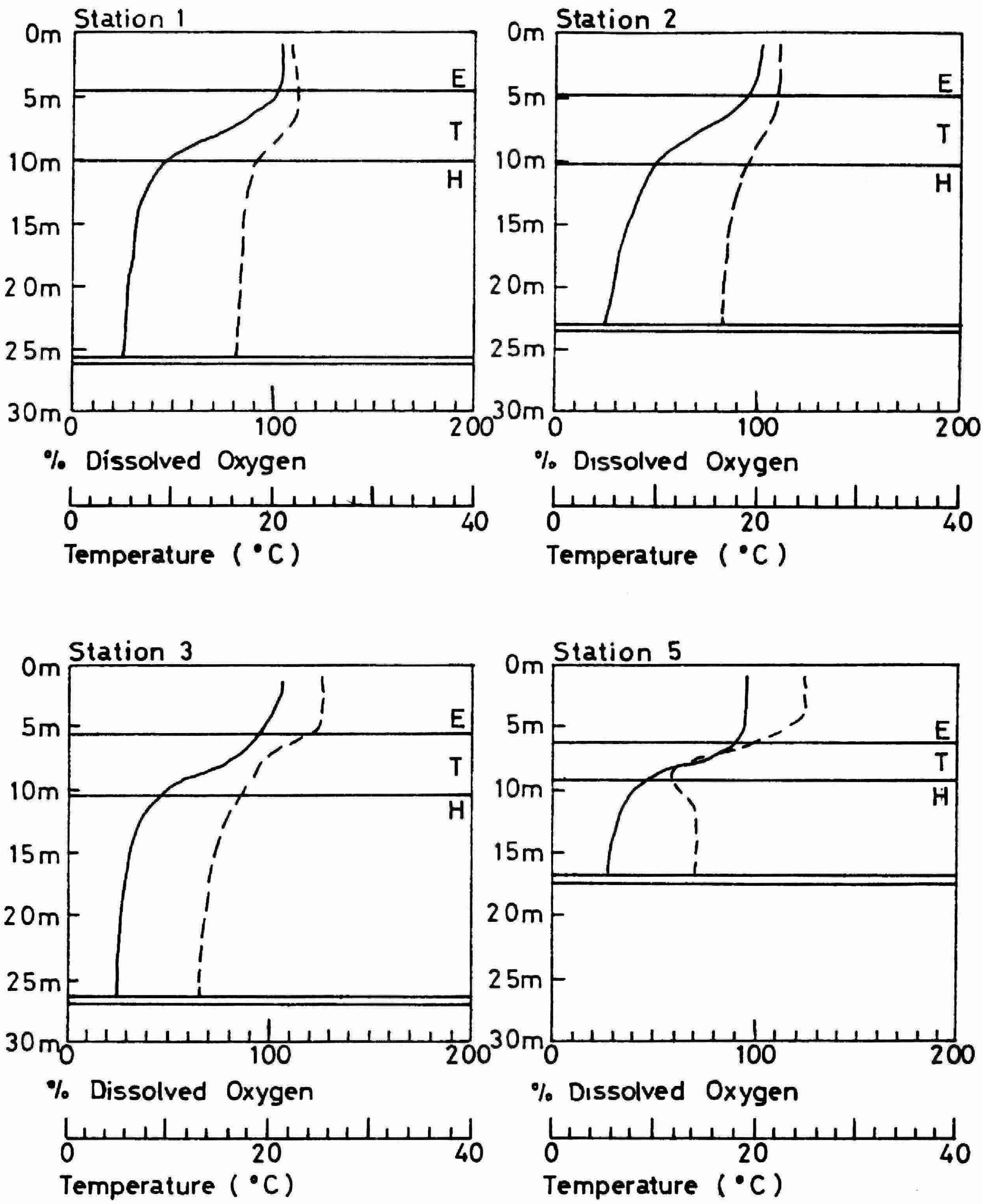
Dissolved oxygen is extremely important in a lake since it is required for respiration by fish and other aquatic life. Dissolved oxygen was found to be reasonably abundant with a minimum recorded concentration of 6 mg l^{-1} Generally, values approached 10 mg l^{-1}. Concentrations of dissolved oxygen within this range are considered adequate for the survival of fish. The highest bottom water dissolved oxygen concentrations occurred at stations 1 and 2 (10 mg l^{-1}) while the lowest levels were detected at stations 3 and 5 (8 mg l^{-1})

In terms of vertical distribution all stations exhibited dissolved oxygen depth profiles which may be termed clinograde based on a reduction in dissolved oxygen with depth - a type of distribution generally considered typical of eutrophic lakes. The profile at station 5 although basically clinograde also exhibits a tendency toward a negative heterograde distribution (lowest dissolved oxygen in the mid-waters). It is important to note that despite the observed dissolved

FIGURE 3.1.1.

TEMPERATURE AND DISSOLVED OXYGEN DEPTH DISTRIBUTIONS

ROUND LAKE - August 14, 1974



E - Epilimnion

T - Thermocline

H - Hypolimnion

—— - Lake Bottom

– – - Dissolved Oxygen

—— - Temperature

oxygen reduction with depth in Round Lake, critical levels were not reached in the bottom waters at the time of sampling. However, low winter dissolved oxygen concentrations have been reported by the Ministry of Natural Resources.

3.2 WATER CHEMISTRY

The results of chemical analyses of water samples from Round Lake are provided in Table II of Appendix B. A summary of ranges in concentration of selected parameters is provided in Table 3.2.1 below:

TABLE 3.2.1

RANGE IN CONCENTRATION OF SELECTED PARAMETERS
ROUND LAKE, 1974

Parameter	Range
pH	7.63 - 8.90
Alkalinity	39 - 46
Conductivity	121 - 124
Hardness	50 - 52
Sodium	4.1 - 4.5
Potassium	1.2 - 1.4
Calcium	16
Magnesium	2 - 3
Sulphate	12.0 - 14.0
Silica	.65 - 3.3
Ammonia	<.01 - .36
Kjeldahl	.39 - .92
Nitrite	.003 - .23
Nitrate	<.01 - .30
Total Phosphorus	.031 - .071
Total Carbon	9 - 11
Total Iron	<.05 - .65

NOTE: All values except pH (units) and conductivity (umho cm-1) reported in mg 1^{-1}.

As indicated in Table 3.2.1, the pH of Round Lake was basic with values generally exceeding 8.5. Stations 1, 2 and 4 showed minor pH decreases between surface and bottom (.1 to .3 units) while stations 3 and 5 showed pH decreases with depth of .9 and .7 units respectively. The lower pH observed in the bottom waters is no doubt a result of the production of organic acids and/or carbon dioxide from the decomposition of bottom materials.

Alkalinity and hardness ranged from 39 to 46 and 50 to 52 mg 1^{-1} as $CaCO_3$ respectively. No significant variation with depth or location was evident.

Conductivity was relatively low (121 to 124 umho cm^{-1}) and correspondingly, concentrations of the major ions sodium, potassium, calcium, magnesium, sulphate, and silica were moderate (see Table 3.2.1). Stations 3 and 5 exhibited significant bottom water silica elevations when compared to the other stations - otherwise, concentrations of the above ions showed reasonable uniformity with depth and location.

Concentrations of total carbon were quite uniform ranging from 9 to 11 mg 1^{-1}.

Iron concentrations showed a wide range (<.05 to .65 mg 1^{-1}) with the highest values occurring in the bottom waters of stations 1 and 5 (.65 and .30 mg 1^{-1} respectively.)

Concentrations of free ammonia showed wide variation (<.01 to .36 mg l^{-1}) with surface water concentrations generally greatly exceeding concentrations in the bottom waters. Kjeldahl nitrogen was found to be abundant in Round Lake with concentrations ranging from .39 to .92 mg l^{-1}. Generally, concentrations of Kjeldahl nitrogen were greatest in the surface waters. Concentrations of nitrite were significantly higher at stations 2 and 4 (.021 to .23 mg l^{-1}) than at the remaining stations (.002 to .009 mg l^{-1}) with surface concentrations exceeding those in the bottom waters. With the exception of station 2 which showed a relatively high surface water nitrate concentration (.30 mg l^{-1}), nitrate values were uniformly <.01 mg l^{-1} in the surface waters of Round Lake. Bottom water nitrate concentrations were significantly higher ranging from .18 to .30 mg l^{-1}.

Concentrations of total phosphorus in Round Lake were also high ranging from .031 to .071 mg l^{-1}.

The observed abundance of water-borne nitrogen and phosphorus in Round Lake is of concern due to the ability of these nutrients to induce aquatic macrophyte and algal growth.

Sawyer (1947) suggested that excessive algal growths may be expected to materialize if total phosphorus and inorganic nitrogen concentrations exceed 20 and 300 ug l^{-1} respectively at the beginning of the growing season. Table 3.2.2 provides a summary of total nitrogen, inorganic nitrogen and total phosphorus values for Round Lake.

TABLE 3.2.2

SUMMARY OF NUTRIENT CONCENTRATIONS, ROUND LAKE, 1974

Station	Depth	Total Nitrogen (Kjeldahl + NO_2 + NO_3)	Inorganic Nitrogen (NH_3 + NO_2 + NO_3)	Total Phosphorus
1	1m	939	379	49
	26m	903	273	59
2	1m	1240	550	35
	23m	1190	530	36
3	1m	794	254	40
	27m	673	293	38
4	1m	791	574	31
	6m	1100	340	38
5	1m	684	214	31
	17m	693	303	71
Mean		901	371	43

Note: Values reported in ug l^{-1} .

As indicated in Table 3.2.2 concentrations of inorganic nitrogen closely approached or exceeded (in some cases by almost two fold) Sawyers' suggested criteria. Likewise, concentrations of total phosphorus were significantly greater than the 20 ug l^{-1} limit suggested by Sawyer. It is important to note that Sawyers' suggested limits are based on spring concentrations while the values for Round Lake represent midsummer conditions. Since significant quantities of nutrients may be tied up in aquatic macrophyte and algal growth during summer, springtime concentrations may be expected to be significantly higher than those reported herein. It is apparent that the recorded concentrations of nutrients are easily capable of inducing algal "water blooms" such as those observed on Round Lake.

3.3 SECCHI DISC - CHLOROPHYLL A.

The results of Secchi disc - chlorophyll a monitoring are provided in Table III of Appendix B. A summary of Secchi disc transparency depths and chlorophyll a concentrations is provided in Table 3.3.1 below.

TABLE 3.3.1

SUMMARY OF SECCHI DISC AND CHLOROPHYLL A DATA, ROUND LAKE, 1974:

Station	Mean Secchi Disc m	Mean Chlorophyll a ug l^{-1}
1	1.7	6.9
2	1.5	8.0
3	1.6	7.2
4	1.6	7.4
5	1.4	7.3
Overall Mean	1.6	7.4

As shown in Table 3.3.1 mean Secchi disc transparencies ranged from 1.4 to 1.7 m with an overall mean of 1.6 m. These readings are similar to the value (1.7 m) reported by Michalski and Robinson (1970) for Riley Lake-considered to be in an advanced state of eutrophication. Further, Vallentyne (1969) has indicated that lakes with Secchi disc readings below 3m are eutrophic. On the basis of these guidelines, the recorded Secchi disc measurements indicate that Round Lake is in a very eutrophic status.

Michalski and Conroy (1972) have indicated that chlorophyll a concentrations between 0 and 5 ug l^{-1} indicate low to moderate algal densities, concentrations between 5.0 and 10.0 ug l^{-1} indicate moderate densities-acceptable for most water oriented recreation, and levels between 10 and 15 ug l^{-1} reflect high algal crops. Vallentyne (1969) has indicated that acceptable chlorophyll a concentrations are <5 ug l^{-1} while levels above 10 ug l^{-1} are dangerous. Figure 3.3.1 is a pictorial representation of fluctuations in chlorophyll a concentrations in Round Lake during the summer months. It is apparent from the figure that concentrations exceeding the dangerouly high level by up to two fold were present during early June. From mid June to late July phytoplankton populations receded somewhat however algal numbers reflected by chlorophyll a concentrations still approached or exceeded 10 ug l^{-1} at intervals. In early August a second bloom was evident with very high chlorophyll concentrations occurring at certain stations.

Ministry of the Environment personnel have shown a near hyperbolic relationship between Secchi disc transparency and chlorophyll a concentrations. Figure 3.3.2 is a graph of this relationship with the values for Round Lake included. It is apparent from the graph that Round Lake occupies a position in the eutrophic area of the curve, intermediate between mesotrophic Lake Ontario and the highly eutrophic western basin of Lake Erie.

FIG. 3.3.1

VARIATION IN CHLOROPHYLL A CONCENTRATIONS DURING SUMMER MONTHS, ROUND LAKE, 1974.

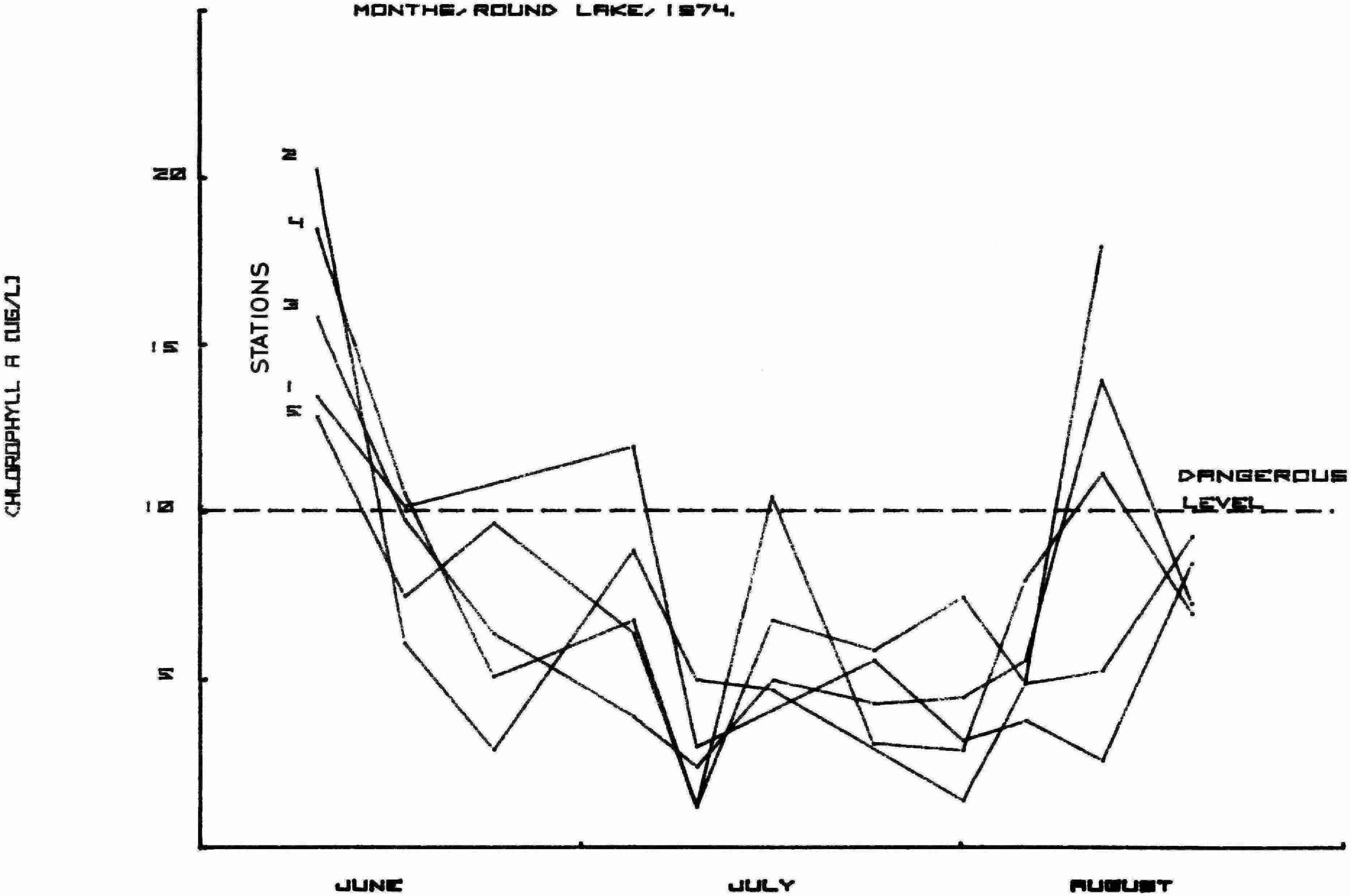
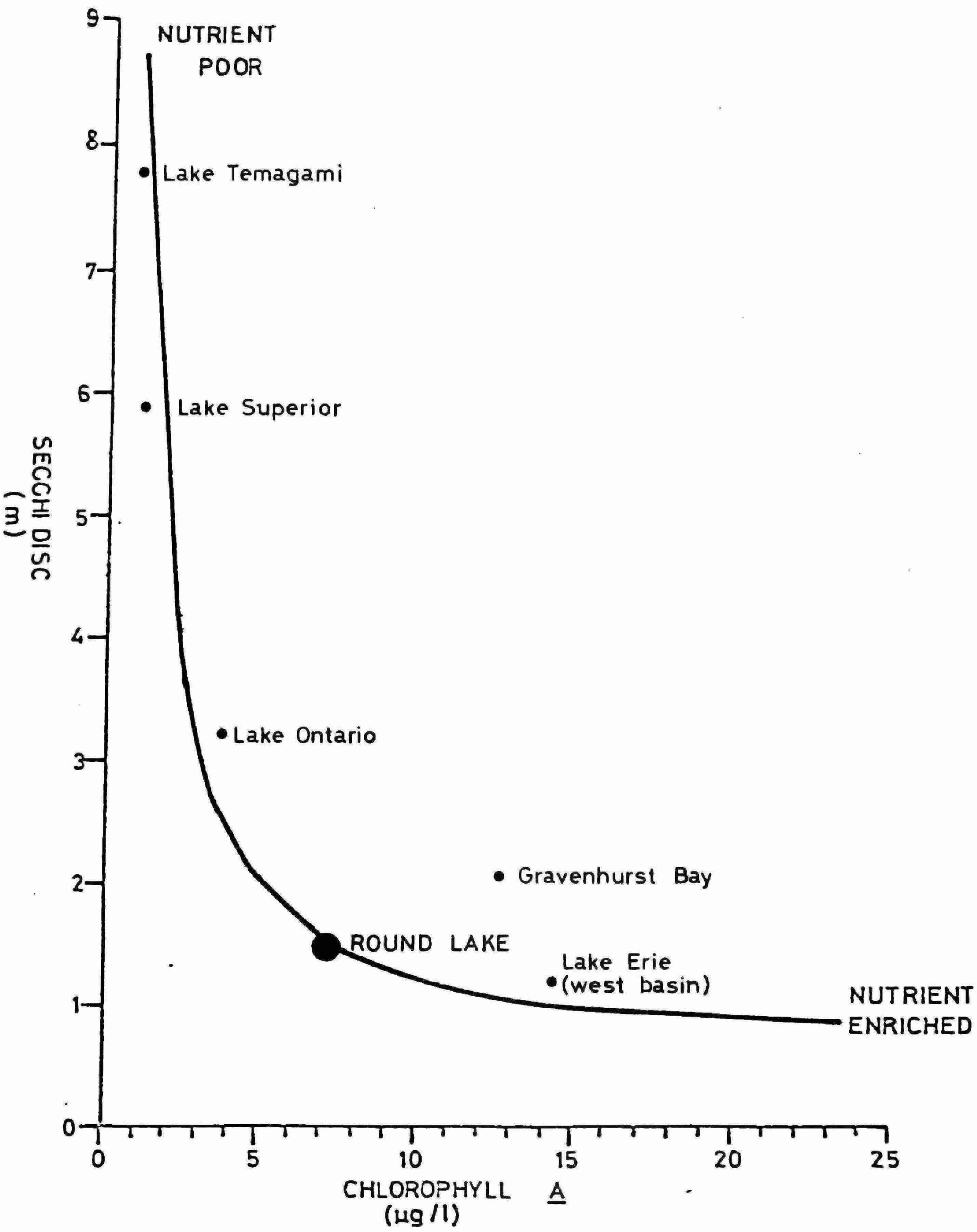


FIGURE 3.3.2 — THE RELATIONSHIP BETWEEN CHLOROPHYLL A & SECCHI DISC AS DETERMINED FROM ONTARIO LAKES



3.4 EFFECTS OF INPUTS FROM THE BLANCHE RIVER

The results of chemical analyses of water samples from the Blanche River, upstream and downstream of Round Lake, are provided in Table 3.4.1 below.

TABLE 3.4.1

SUMMARY OF WATER QUALITY IN THE BLANCHE RIVER
UPSTREAM AND DOWNSTREAM OF ROUND LAKE, 1974

	UPSTREAM (A)				DOWNSTREAM (B)			
	28/6/74	31/7/74	14/8/74	Mean	28/6/74	31/7/74	14/8/74	Mean
CONDUCTIVITY (umho cm^{-1})	111	117	133	120	120	126	123	123
NITROGEN (mg l^{-1})								
Free Ammonia	.02	< .01	< .01	.01	.11	< .01	< .01	.04
Kjeldahl	.40	.40	.43	.41	.51	.40	.44	.45
Nitrite	.022	.022	.003	.01	.012	.004	.003	.006
Nitrate	.06	< .01	.16	.08	.01	.22	.05	.09
PHOSPHORUS (mg l^{-1})								
Total	.070	.075	.098	.081	.055	.020	.030	.035
Soluble	.026	.053	.059	.046	.020	.019	.007	.015

As indicated in Table 3.4.1, conductivity was similar upstream and downstream of Round Lake (mean values = 120 and 123 umho cm^{-1} respectively). These values were very close to the concentrations reported for the lake water (121 to 124 umho cm^{-1}).

Total phosphorus concentrations in the Blanche River upstream of Round Lake were found to be very high (.070 to .098 mg l^{-1}) - significantly higher than concentrations in the lake water (.031 to .071 mg l^{-1}) and downstream (.020 to .055 mg l^{-1}). The significant phosphorus reduction observed between the inflow and outflow is no doubt attributable to uptake by algae and incorporation into the bottom sediments of the lake.

The high phosphorus concentrations recorded in the inflow to Round Lake are of major concern due to the potential of this nutrient to induce nuisance populations of algae. The high phosphorus concentrations in the lake water and the resultant high phytoplankton populations are no doubt a result of significant phosphorus inputs via the Blanche River.

Vollenweider, 1973, has proposed a model relating total phosphorous loading to trophic status. Figure 3.4.1 is a representation of this model including the position of Round Lake. Table 3.4.1 provides a summary of pertinent data and calculations involved in situating Round Lake on Vollenweider's graph.

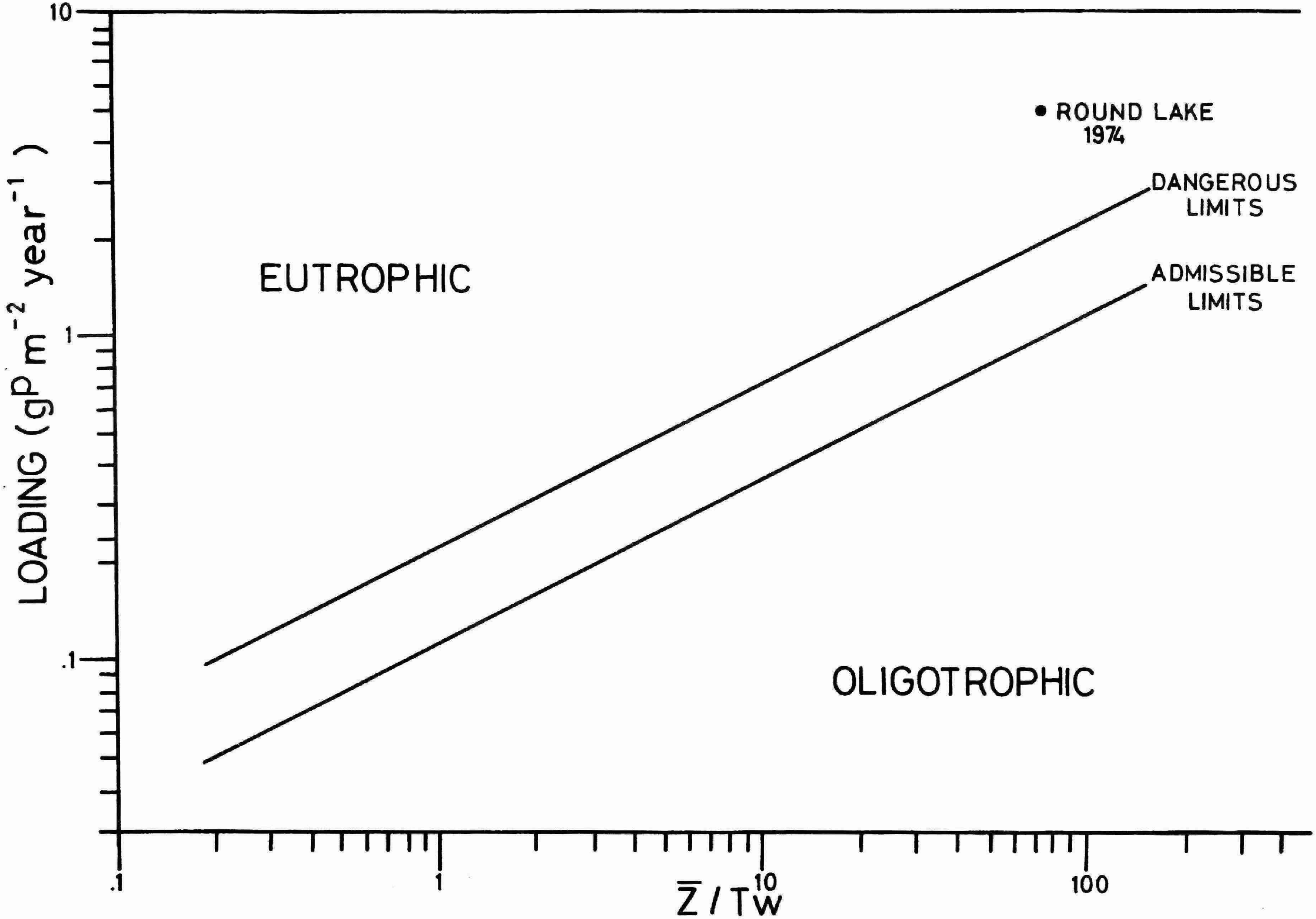
TABLE 3.4.1

Volume (V)		$= 1.66 \times 10^{-8}\ m^{-3}$	
Mean Depth ($\bar{z}$)		$= 13.7\ m$	
Surface Area (A)		$= 1.2 \times 10^{-7}\ m^{-2}$	
Flow (F)		$= 7.6 \times 10^{-8}\ m^{-3}\ yr^{-1}$	
Phosphorus Concentration (C)		$= .081\ g\ m^{-3}$	
Retention Time (Tw)	$= \frac{V}{F}$	$= \frac{1.66 \times 10^{-8}\ m^{-3}}{7.6 \times 10^{-8}\ m^{-3}\ yr^{-1}}$	$= .218\ yr^{-1}$
A. Phosphorus Loading		$= \frac{C \times F}{A}$	
		$= \frac{.081\ g\ m^{-3} \times 7.6 \times 10^{-8}\ m^{-3}\ yr^{-1}}{1.2 \times 10^{-7}\ m^{-2}}$	
		$= 5.13\ g\ m^{-2}\ yr^{-1}$	
B. $\bar{z}$/ Tw		$= \frac{13.7}{.218}$	
		$= 62.8$	

Note: Morphometric data provided by Ministry of Natural Resources, Kirkland Lake.

It is apparent from figure 3.4.1 that Round Lake falls within the eutrophic area of the graph - greatly exceeding the dangerous loading limits suggested by Vollenweider. It should be noted that figure 3.4.1 only indicates that phosphorus loading contributed by the Blanche River and does not consider additional sources such as precipitation, land drainage export and lakeshore development which would significantly increase the total loading.

FIGURE 3.4.1. — ANNUAL TOTAL PHOSPHORUS LOADING VIA THE BLANCHE RIVER, 1974



As well, concentrations of total nitrogen, (Kjeldahl, nitrate and nitrite) were very high in the Blanche River upstream and downstream of Round Lake (.50 and .55 mg l^{-1} respectively) although they were significantly lower than the concentration in the lake water (mean - .90 mg l^{-1}).

Vollenweider, 1968, has suggested that for lakes with a mean depth between 10 and 50 m - such as Round Lake, a nitrogen loading of up to 4.0 g m^{-2} yr^{-1} is permissible while a loading in excess of 8.0 g m^{-2} yr^{-1} is dangerous. The nitrogen loading calculation for Round Lake is provided below.

Total Nitrogen Concentration (C) = .50 mg m^{-3}
Flow (F) = 7.6×10^{-8} m^{-3} yr^{-1}
Surface Area (A) = 1.2×10^{-7} m^{-2}

$$\text{Nitrogen loading} = \frac{C \times F}{A}$$

$$= \frac{.50 \text{ g m}^{-3} \times 7.6 \times 10^{-8} \text{ m}^{-3} \text{ yr}^{-1}}{1.2 \times 10^{-7} \text{ m}^{-2}}$$

$$= 31.7 \text{ g m}^{-2} \text{ yr}^{-1}$$

It is apparent that the input of nitrogen via the Blanche River is extremely high, exceeding the dangerous loading limit by four fold.

It is important to realize that phosphorus and nitrogen concentration data employed in the foregoing calculations is based on a limited number of samples collected only during the summer which may not completely reflect conditions for the whole year.

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ACKNOWLEDGEMENTS

The participation of the following persons and agencies is gratefully acknowledged.

Local citizens carried out the weekly sampling for chlorophyll *a* and Secchi disc. Their participation was essential since this data formed the basis for the trophic status evaluation of the lake. Particular thanks are given to Mr. J. D. Archer for his efforts in the organization and implementation of the sampling programme.

Miss Julie Delabbio, student assistant with the Ministry of the Environment, assisted in the collection of the intensive water quality data.

Morphometric data on Round Lake was provided by the Ministry of Natural Resources, Kirkland Lake.

APPENDIX "A"

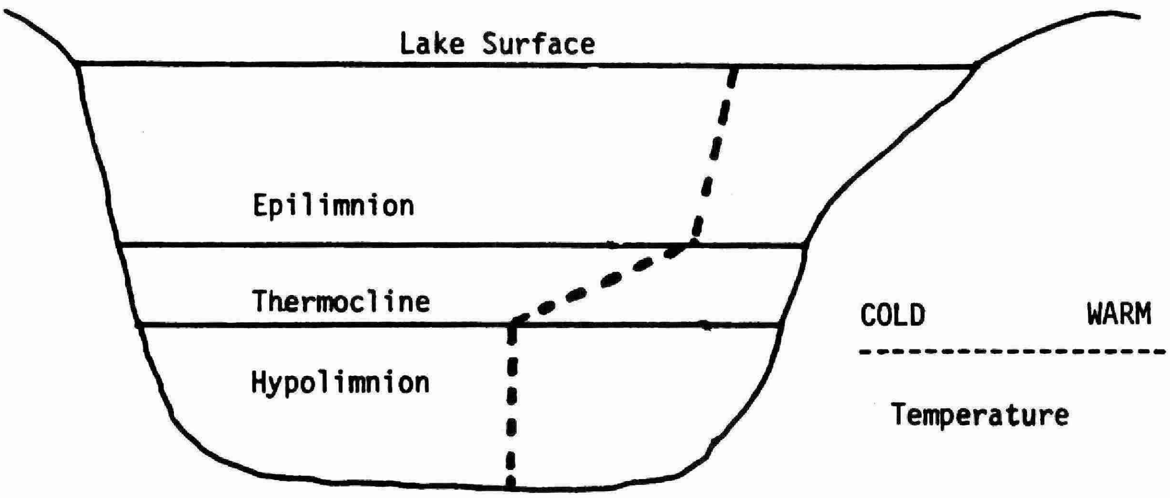
GLOSSARY

G L O S S A R Y

EPILIMNION - lakes which show thermal stratification have three distinct layers. The upper layer of water in which the temperature is relatively uniform is the epilimnion (see Figure A).

FIGURE A

Sketch of cross-section of theoretical lake during thermal stratification indicating water layers and temperature distribution.



EUPHOTIC ZONE - the intensity of light diminishes as it passes through water until at some depth there is insufficient light to carry on photosynthesis. This zone of significant light penetration is the euphotic zone.

EUTROPHIC - lakes are classified into three catagories on the basis of the biological activity - those with high biological activity and large nutrient concentrations are eutrophic. Characteristically eutrophic lakes are shallow, warm and highly turbid (see oligotrophic, mesotrophic and trophic status).

EUTROPHICATION - the process by which lakes become increasingly enriched in nutrients. It refers to the entire complex of changes which accompany nutrient enrichment including dense growth of algae and aquatic weeds.

HYPOLIMNION - the uniformly cold layer of water lying beneath the thermocline in thermally stratified lakes, (see Figure A).

MESOTROPHIC - those lakes with a moderate supply of nutrients and moderate biological activity, i.e. a trophic status lying between oligotrophic and eutrophic.

OLIGOTROPHIC - lakes with a meagre supply of nutrients and low biological activity. Characteristically oligotrophic lakes are deep, cold water, highly transparent bodies of water.

pH - a measure of acidity/alkalinity on a scale from 0-14 where 7.0 is neutral and 6.9-0 indicates increasing acidity and 7.1 to 14 increasing alkalinity.

strongly acid	acid	neutral	basic	strongly basic
0-3.9	4-6.9	7.0	7.1-10	10.1-14
		natural water		

THERMOCLINE - the mid layer of water in thermally stratified bodies of water in which the rate of change of temperature is a maximum.

TROPHIC STATUS - lakes are classified on the basis of the degree of nutrients enrichment and biological acitivity into three integrating types; oligotrophic, mesotrophic and eutrophic. Additions of nutrients to infertile lakes (oligotrophic) tned to make them mesotrophic and with continued enrichment they will become eutrophic.

APPENDIX B

DATA TABLES

TABLE I

RESULTS OF TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS,
ROUND LAKE, AUGUST 14, 1974

STATION	DEPTH	TEMPERATURE	DISSOLVED	OXYGEN
	METRES	^{o}C	% SATURATION	$mg\ l^{-1}$
1	1	20.2	113	10
	5	20.0		
	6	17.8		
	7	15.8	115	11
	8	13.9		
	9	11.0		
	10	9.1	90	10
	12	7.4		
	14	6.5		
	20	5.5		
	26	5.0	81	10
2	1	20.2	113	10
	3	19.7		
	5	18.8	111	10
	6	16.3		
	7	14.8	102	10
	8	12.5		
	9	11.5	95	10
	10	10.0		
	12	8.3		
	14	7.5		
	18	6.2		
	23	5.1	81	10
3	1	20.2	125	11
	5	19.0	122	11
	6	17.5		
	7	12.2	96	10
	8	10.5		
	9	9.8		
	10	8.6	88	10
	11	8.0		
	12	7.0		
	13	6.8		
	27	5.0	65	8
4	1	20.1	136	12
	2	19.8		
	3	19.4		
	4	19.1	100	9
	5	19.0		
	6	18.7	99	9

TABLE I

RESULTS OF TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS
ROUND LAKE, AUGUST 14, 1974

STATION	DEPTH	TEMPERATURE	DISSOLVED	OXYGEN
	METRES	^{o}C	% SATURATION	$mg\ l^{-1}$
5	1	19.7	124	11
	5	19.0	122	11
	6	18.9		
	7	16.0		
	8	11.2	56	6
	9	9.0		
	10	8.0		
	12	7.0	68	8
	14	7.0		
	17	6.3	67	8

TABLE II

RESULTS OF CHEMICAL ANALYSES, ROUND LAKE AUGUST 14, 1974

STATION	DEPTH m	pH	ALKALINITY mg l^{-1} $CaCO_3$	CONDUCTIVITY umho cm^{-1}	HARDNESS mg l^{-1} $CaCO_3$	SODIUM mg l^{-1}	POTASSIUM mg l^{-1}	CALCIUM mg l^{-1}	MAGNESIUM mg l^{-1}	SULPHATE mg l^{-1}
1	1	8.82	46	122	50	4.3	1.3	16	2	12.5
	26	8.52	39	121	50	4.4	1.3	16	2	12.5
2	1	8.90	43	121	50	4.2	1.2	16	2	12.5
	23	8.79	43	123	51	4.1	1.2	16	3	12.5
3	1	8.78	45	121	50	4.2	1.2	16	2	12.5
	27	7.90	40	124	52	4.5	1.4	16	3	14.0
4	1	8.60	40	121	50	4.2	1.2	16	2	12.5
	6	8.52	43	122	51	4.2	1.2	16	3	12.5
5	1	8.37	42	122	51	4.2	1.2	16	3	12.0
	17	7.63	44	124	51	4.5	1.4	16	3	12.5

STATION	DEPTH m	NITROGEN (mg l^{-1}) NH_3	Kjeldahl	NO_2	NO_3	TOTAL PHOSPHORUS mg l^{-1}	SILICA mg l^{-1}	TOTAL CARBON mg l^{-1}	IRON mg l^{-1}
1	1	.36	.92	.009	<.01	.049	.65	10	.10
	26	<.01	.64	.003	.26	.059	.70	10	.65
2	1	.02	.71	.23	.30	.035	1.0	10	.15
	23	<.01	.67	.22	.30	.036	.70	10	.10
3	1	.24	.78	.004	<.01	.040	.85	11	.10
	27	.01	.39	.003	.28	.038	3.0	9	<.05
4	1	.25	.76	.021	<.01	.031	.95	10	<.05
	6	<.01	.77	.15	.18	.038	.83	10	.15
5	1	.20	.67	.004	<.01	.031	1.1	11	.10
	17	<.01	.40	.003	.29	.071	3.3	10	.30

<u>TABLE III</u>

RESULTS OF SECCHI DISC - CHLOROPHYLL A SAMPLING, ROUND LAKE
AUGUST 14, 1974.

STATION	DATE	SECCHI DISC	CHLOROPHYLL A
		(M)	(ug l^{-1})
1	9/6/74	1.5	13.5
	16/6/74	1.8	10.2
	4/7/74	2.0	12.0
	9/7/74	2.0	3.0
	23/7/74	1.8	5.6
	31/7/74	-	3.2
	5/8/74	1.0	3.8
	11/8/74	2.4	2.6
	18/8/74	1.5	8.5
	MEAN	1.7	6.9
2	9/6/74	1.3	20.3
	16/6/74	1.2	6.1
	23/6/74	1.3	2.9
	4/7/74	1.5	8.9
	9/7/74	1.6	5.0
	15/7/74	1.9	4.7
	31/7/74	-	1.4
	5/8/74	1.9	4.9
	11/8/74	1.2	18.0
	MEAN	1.5	8.0
3	9/6/74	1.3	15.9
	16/6/74	1.4	9.8
	23/6/74	1.6	6.4
	4/7/74	1.5	3.9
	9/7/74	1.7	2.4
	15/7/74	1.5	5.0
	23/7/74	2.2	4.3
	31/7/74	-	4.5
	5/8/74	1.9	5.6
	11/8/74	1.4	14.0
	18/8/74	1.4	7.3
	MEAN	1.6	7.2
4	9/6/74	1.2	18.5
	16/6/74	1.1	10.6
	23/6/74	1.4	5.1
	4/7/74	1.8	6.8
	9/7/74	1.8	1.2
	15/7/74	1.5	6.8
	23/7/74	2.3	5.9
	31/7/74	-	7.5
	5/8/74	1.9	4.9
	11/8/74	1.3	5.3
	18/8/74	1.3	9.3
	MEAN	1.6	7.4

TABLE III

RESULTS OF SECCHI DISC - CHLOROPHYLL A SAMPLING, ROUND LAKE, AUGUST 14, 1974.

STATION	DATE	SECCHI DISC	CHLOROPHYLL A
		(M)	(ug 1^{-1})
5	9/6/74	1.2	12.9
	16/6/74	1.1	7.5
	23/6/74	1.5	9.7
	4/7/74	1.8	6.4
	9/7/74	1.2	1.2
	15/7/74	1.2	10.5
	23/7/74	1.9	3.1
	31/7/74	-	2.9
	5/8/74	1.9	8.0
	11/8/74	1.2	11.2
	18/8/74	1.3	7.0
	MEAN	1.4	7.3